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MINERALOGICAL NOTES No. 2*

By

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(Figures 1-5.)

On the Identity of " Green Rhodonite " with Manganhedenbergite

Dr. F. L. Stillwell[1] has described a mineral from Broken Hill, New South Wales, under the provisional name of " Green Rhodonite." Not having obtained a specimen of this mineral the writer took the opportunity of a generous offer of Mr. A. Fairweather, Manager of the South Mine, Broken Hill, to collect a quantity of this material from section E, 725-ft. level. Later a specimen from The Pinnacles was submitted for determination, which proved to be identical with the material from the main Broken Hill lode. So distinct in general appearance was this material from rhodonite that it seemed that the term " Green Rhodonite " was misleading at least.

Taking the analysis by Mr. F. H. Searcy[2] quoted by Dr. Stillwell, it will be seen from the following table that chemically the mineral is practically identical with manganhedenbergite, from Dognacska.[3]

	1	2	3
SiO_2	48.30	48.38	8
Al_2O_3	3.22	0.68	} .5
Fe_2O_3	2.04	3.23	
FeO	17.10	15.88	} 3.5
MnO	7.10	7.94	
CaO	22.54	22.10	4
MgO	nil	2.22	
Alkalies	......	0.28	
	100.30	100.71	

1. " Green Rhodonite," Broken Hill.
2. Manganhedenbergite, Dognacska.
3. Molecular Ratio from No. 1.

*For No. 1, see " Records," vol. xiv., No. 2, 1923, p. 101.

[1]Andrews—Mem. Geol. Surv. N.S.W., Geol., No. 8, 1922, App. II (Stillwell), pp. 385-386.

[2]Mr. H. P. White, Analyst and Assayer to the Geological Survey of New South Wales, has shown me an analysis made by himself which agrees substantially with that by Searcy.

[3]Dana—System of Mineralogy 6th Ed., 1892, p. 359.

It is at once obvious that the composition of the so-called " Green Rhodonite " from Broken Hill approximates the formula Ca(Fe,Mn) $(SiO_3)_2$, which is that of manganhedenbergite.

Dr. Stillwell compares the mineral chemically with babingtonite, pointing out that the difference lies in the fact that the iron content of babingtonite is half in the ferrous and half in the ferric state. This is a very important difference, as the composition of babingtonite may be represented as (Ca,Fe,Mn) SiO_3 with $Fe_2(SiO_3)_3$. The ratio of these two molecules as derived from the analysis of the " Green Rhodonite " is 23:1, while the ratio in the babingtonite quoted is only 9:1. The specific gravity of the mineral as determined by Mr. C. M. G. Friend is 3.53, while that given by Dana for the Dognacska manganhedenbergite is 3.55. The specific gravity of babingtonite is 3.35 to 3.37.

A number of cleavage fragments was obtained and two were measured on a two-circle goniometer. The signals obtained were not satisfactory. The following is a table of the results of measurement.

Interfacial Angle	Measured	Calculated	Error.
	° ′	° ′	′
$a(100) \wedge b(010)$	90 13	90 00	13
$a(100) \wedge m(110)$	46 22	46 25	3
$a(100) \wedge c(001)$	75 09	74 10	59

Of these the cleavage faces *c*(001) and *b*(001) are not true cleavages but merely partings, due probably to twinning. Lamellar twinning is shown in thin sections.

From one of the measured fragments sections were cut parallel to *c*(001), *b*(010), and *a*(100) and examined under the microscope.

The section parallel to *c*(001) shows the traces of three cleavages. One cleavage is pinacoidal parallel to *a*(100), while the other two are prismatic parallel to *m*(110). The angle between the traces of the latter two cleavages is approximately 93°. Complete extinction was not obtained, as the section is nearly at right angles to an optic axis. The optical axial plane is at right angles to the pinacoidal cleavage, and is therefore parallel to *b*(010).

The section on *b*(010) shows the traces of the prismatic and pinacoidal cleavages parallel to one another, and a distinct parting parallel to *c*(001). The angle between the two sets of cleavages is approximately 75°. The extinction angle measured in reference to the traces of the prismatic cleavage is 44° 30′.

The section cut parallel to *a*(100) shows the parting parallel to *c*(001) and the traces of the prismatic cleavage. The section is not quite at right angles to an optic axis. The plane of the optical axial angle is at right angles to the trace of the parting parallel to *c*(001), that is parallel to *b*(010).

The mineral is optically positive. The optic axial angle is large and the double refraction strong.

Optically the mineral is identical with a monoclinic pyroxene, with the exception that the measurements of the angle β do not agree with those given for any pyroxene. The angle measured on the goniometer and that measured on the section parallel to $b(010)$ give an angle that is nearly a degree too large. Unfortunately, as the original description of manganhedenbergite[4] is not available to me, I am unable to say whether this variation has been noticed before.

In my opinion the name "Green Rhodonite" should be discarded for manganhedenbergite, with which the mineral is identical.

Albite.

Upper Bingara, New South Wales.

The Australian Museum collection contains a number of specimens of crystallised albite lining crevices and vesicles of a highly altered rock. These were presented to the Trustees by Mr. D. A. Porter, who first discovered them.

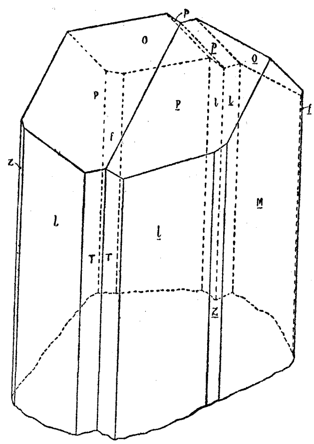

Fig. 1. Albite twinned according to the albite law, from Upper Bingara, New South Wales. Forms—$P(001)$, $M(010)$, $f(130)$, $T(110)$, $l(\bar{1}10)$, $z(1\bar{3}0)$, $p(\bar{1}11)$, and $o(\bar{1}\bar{1}1)$.

Prof. W. N. Benson[5] has described albite from this locality, but only as a rock constituent. He states that "in the hand specimens, it appears to be a gabbroid rock that has been highly sheared and veined.

[4]Weibull—Geöl. För. Forh. Stockholm, vi, 1883, p. 505.

[5]Benson—The Geology and Petrology of the Great Serpentine Belt of N.S.W. Pt. iii, Proc. Linn. Soc. N.S.W., xxxviii, 1913, p. 687.

Mineralogically it is altered beyond recognition as a gabbro. It consists chiefly of tremolite . . . set in a ground mass of albite-felspar . . . The rest of the rock is made up of large veins of prehnite." It is apparently this rock in which Porter discovered the albite associated with well crystallised clear quartz. The albite crystals are twinned according to both the albite and pericline laws, the latter being indicated only by striations on *M*(010). They vary in size up to 3 mm. in length. The habit is fairly constant, crystals being more or less tabular, parallel to *b*. Generally the colour is milky when the crystals are transparent only on the thin edges, otherwise they are colourless and transparent. The following forms have been recognised—*P*(001), *M*(010), *f*(130), *T*(110), $l(\bar{1}10)$, $z(\bar{1}30)$, $p(\bar{1}11)$ and $o(\bar{1}\bar{1}1)$. A brachydome is present in many crystals, but the faces either produced a series of blurred signals or else no signal at all. The faces were striated due to polysynthetic twinning, and, although bright, in general gave blurred signals. The following table gives the measured and calculated angles :—

Form	Measured		Calculated		Error	
	φ	ρ	φ	ρ	φ	ρ
	° ′	° ′	° ′	° ′	′	′
P(001)	81 48	27 22	81 51	27 01	3	21
M(010)	0 08	90 00	0 00	90 00	8	
f(130)	29 58	90 00	30 23	90 00	25	
T(110)	60 05	90 00	60 30	90 00	25	
$l(\bar{1}10)$	119 22	90 00	119 52	90 00	30	
$z(\bar{1}30)$	149 26	90 00	149 44	90 00	18	
$p(\bar{1}11)$	36 36	38 41	36 53	38 30	17	11
$o(\bar{1}\bar{1}1)$	134 54	34 13	135 21	34 11	27	2

Only the colourless crystals were chosen for analysis, with the following result :—

SiO_2	66.98		
Al_2O_3	20.07	Or	0.55
CaO	0.80	Ab	95.36
MgO	trace	An	3.89
Na_2O	11.32		
K_2O	0.17		
	99.34		

This places the composition of the felspar as $Ab_{96}An_4$. The extinction on *b* with reference to the edge *b*/*c* is 18° 30′.

With reference to the occurrence of the albite, it is of interest to note that gabbro dykes intruding the Great Serpentine Belt of New South Wales are altered to tremolite-prehnite-albite rocks and to pyroxene-prehnite-grossularite rocks. These dykes have been intruded very shortly after the injection of the ultra-basic magma, and have been subjected to the metamorphic agencies which have produced the serpentine. They are highly crushed rocks, and like the serpentine are much slickensided. In dealing with the occurrence of grossularite in these rocks at Bowling Alley Point[6] I suggested that the magmatic solutions containing silica and a little carbon dioxide, injected together with the gabbro or very shortly after, were responsible for the production of the grossularite. There is no evidence of alkaline solutions having had any part in the alteration of the dykes here. It might be mentioned that at Bowling Alley Point there is an occurrence of albitised dolerite, which according to Benson is older than the serpentine and intruded by it, but it is impossible to state whether albitisation took place before or during the intrusion of the serpentine with its dykes and intruded masses of gabbro.

Regarding the alteration of these dykes there appear to be three possibilities to be considered, namely: (a) the original gabbro rocks were of different composition; or (b) the solutions responsible for the alteration of the gabbro were different in composition; or (c) the grossularite and albite were crystallised by the action of a common solution on similar rocks under different conditions.

(a) If the rock was of different composition from the usual type, which is characterised by the very basic felspar anorthite, and the solutions responsible for the alteration were non-alkaline, as deduced from the evidence at Bowling Alley Point, the felspar of the original rock would be labradorite. The evidence on this point is somewhat slender but is wholly against such a supposition.

(b) The assumption that the magmatic solutions varied in composition would be a very convenient way of explaining the facts. But as the grossularite-bearing dykes occur along the strike of the serpentine belt for many miles, and at Upper Bingara are in fairly close proximity to the albite-bearing dykes, it seems unreasonable to assume a variation in composition of such magnitude.

(c) If it is assumed that magmatic solutions were constant in composition, it is necessary to explain the fact that the alteration product of some of the dykes is albite and of others grossularite. It is at once obvious that the solution acting on the same rock must be capable of producing both minerals. So far as the field evidence goes there appears to be no association of these two minerals. The alteration of all the dykes has been effected by great pressure and the interaction of magmatic solutions either during the intrusion or very shortly after. Both albite and grossularite are high temperature minerals. The evidence of the form of silica deposited in the vesicles and crevices of the dykes is important. Where grossularite has crystallised out, chalcedony is the associated mineral, but where albite has crystallised, the silica is in the form of well crystallised quartz. The only other locality known to me where albite occurs in the serpentine belt is at Wood's Reef, and it is significant that at both these

[6]Smith—Mineralogical Notes No. 1, Rec. Austr. Mus., xiv, 2, 1923, p. 104.

localities the outcrop of the serpentine is notably wider than at any of the localities where grossularite is found.

It is concluded that the solutions responsible for the alteration of the dykes contained soda in addition to silica and a little carbonic acid, but that in general the conditions of recrystallisation were unfavourable to the formation of soda-bearing minerals, and the dykes have been converted into grossularite-bearing rocks. In exceptional circumstances, due to variation of temperature, or pressure, or both, the albite was formed at the expense of grossularite.

Autunite.

Mount Painter, South Australia.

The Australian Museum collection contains a number of specimens of crystallised autunite from Mount Painter. It occurs as greenish-yellow to canary-yellow crystal aggregates, on an ironstone-quartz matrix. The best descriptions of the field occurrence are given by L. K. Ward.[7]

A number of crystals were selected for measurement, but only one was found to give signals, and they were very much distorted. In every case the faces were etched. The following forms were recognised :— *a*(100), *b*(010), *c*(001), and *d*(101). The crystal measures 2 x 2 mm., measured along the *a* and *c* axes, and is very thin, i.e., it is tabular on the *b*(010) face.

An analysis of crystals freed from impurities was made by Mr. W. A. Greig, senior analyst, Geological Survey of New South Wales, with the following result :—

Analysis		Molecular Ratio	Ratio
	%		
P_2O_5	14.80	.104	1.00
UO_3	58.85	.206	1.98
CaO	6.56	.117	} 1.18
MgO	0.26	.006	
H_2O	19.60	1.089	10.47
	100.07		

Specific Gravity = 3.198.

From the above analysis it will be seen that the formula approximates $CaO. 2UO_3.P_2O_5 + 10\frac{1}{2}H_2O$. The formula given by Dana for autunite contains only eight molecules of water, but it is pointed out that analyses show variations up to twelve molecules.

[7]Review Mining Operations South Australia . . . December 31st 1912, No. 17, pp. 27-32; *ibid*, June 30th 1914. No. 20, pp. 36-38.

MOLYBDENITE.

KINGSGATE, NEW SOUTH WALES.

The Australian Museum collection contains a crystal of molybdenite from Kingsgate, New South Wales. It is partly enclosed in quartz and is approximately 10 mm. in diameter and 2 mm. thick. Unfortunately it is slightly bent, making accurate measurements impossible. It is interesting to note that the basal plane *c*(0001) is undoubtedly present. The only other form present is a pyramid, and to determine this form the crystal was mounted on a two-circle goniometer with the vertical circle locked. The edges of a pyramid and the basal plane were adjusted so as to be vertical. As eight faces of the pyramid are present it was necessary to mount the crystal in four different positions. No attempt was made to distinguish positive and negative forms. Three of the faces gave practically a continuous series of signals through a rotation of 90°, and another face yielded two signals which gave an angle with the basal plane of 81° 34′ and 59° 06′. Neglecting the former measurement, the following are the measured angles

	°	′
	55	26
	55	31
	59	06
	56	03
	57	10
Average angle	56	39

Taking $\dot{c} = 1.908$ as assumed by Brown[8], this corresponds fairly closely to $t(20\bar{2}3)$. The calculated angle is 55° 45′.

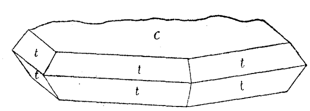

Fig. 2. Molybdenite, Kingsgate, New South Wales. Forms—*c*(0001) and $t(20\bar{2}3)$.

The pyramids are striated parallel to the edge *c*:*t*, and in a lesser degree parallel to the edge *t*:*t*. Striations on the basal plane are parallel to the edge *c*:*t*.

[8]Brown—Proceedings, Academy of Natural Sciences, Philadelphia, 1896, p. 210.

ZIRCON.

ANAKIE, QUEENSLAND.

Mr. H. Macnamara presented to the Trustees a crystal of zircon from Sapphire Town, Anakie, Queensland, which has been measured on a two-circle goniometer. It measures 7 mm. x 4 mm. x 3 mm., and belongs to the variety hyacinth, with a specific gravity of 4.69.

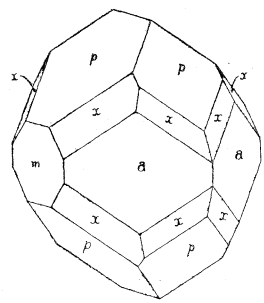

Fig. 3. Zircon from Anakie, Queensland. Forms—*a*(100), *m*(110), *p*(111), and *x*(131).

Zircons in this district occur in alluvial deposits associated with sapphire and pleonaste. Crystals suitable for measurement appear to be somewhat rare.

The following table gives the calculated and measured φ and ρ angles.

Form	Measured		Calculated		Difference	
	φ	ρ	φ	ρ	φ	ρ
	° ′	° ′	° ′	° ′	′	′
a(100)	0 30	90 01	0 0	90 00	30	01
m(110)	45 01	90 01	45 0	90 00	01	01
p(111)	45 05	42 10	45 0	42 09	05	01
x(131)	18 28	63 44	18 26	63 43	02	01

ROCKY RIVER, URALLA, NEW SOUTH WALES.

The Australian Museum collection contains a great number of zircons from this locality. Mr. D. A. Porter[9] has already described the zircons

[9]Porter—Proc. Roy. Soc. N.S.W., xxii, 1888 (1889), p. 84.

from here. He states that they occur in auriferous drift with titanic iron, topaz, and sapphires. He also notes that " the prismatic form, if at all existing must be extremely rare, as not one example was observed in the examination of some thousands of specimens." As a matter of fact quite a number of the crystals in the collection have prism forms present and well developed, though the majority are simple bi-pyramids. In two crystals measured the following forms were identified, *a*(100), *m*(110), and *p* (111).

Diamond.

Copeton, New South Wales.

Mr. G. W. Card, A.R.S.M., Curator of the Mining and Geological Museum, Sydney, very kindly lent a twin crystal of diamond from Copeton, New South Wales for measurement.

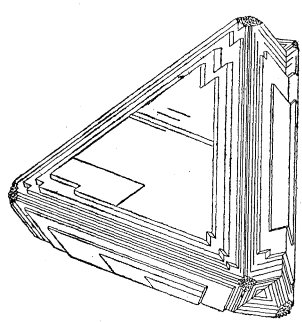

Fig. 4. Diamond twinned according to the spinel law, from Copeton, New South Wales.

The crystal weighs 0.1202 grammes. It is colourless and consists of the octahedron twinned on the octahedral face (spinel law). Both components of the twin are flattened parallel to the twin plane, and are built up of successive plates parallel to this plane. The faces are bright and give excellent signals except those forming the re-entrant angles of the twin.

ANGLESITE.

NORTHERN TERRITORY.

Some crystals were obtained from a specimen of anglesite from Eveleen Mine, 130 miles from Port Darwin, Northern Territory. They range from microscopic size up to 4 mm. x 3 mm. x 3 mm., and occur in two distinct habits. The larger crystals are stout and doubly terminated and the smaller are slender prisms elongated parallel to the *c* axis. The basal plane when present is striated parallel to the edge *d:c* ; the remaining faces were all more or less corroded and generally they gave somewhat blurred signals. The following table gives the measured and calculated φ and ρ angles.

Forms	Measured		Calculated		Difference	
	φ	ρ	φ	ρ	φ	ρ
	° ′	° ′	° ′	° ′	′	′
c(001)	...	00 00	...	00 00		
m(110)	51 55	89 59	51 51	90 00	04	01
o(011)	06	52 12	00	52 12	06	–
d(102)	90 00	39 24	90 00	39 23	–	01
z(111)	51 36	64 44	51 51	64 24	15	20

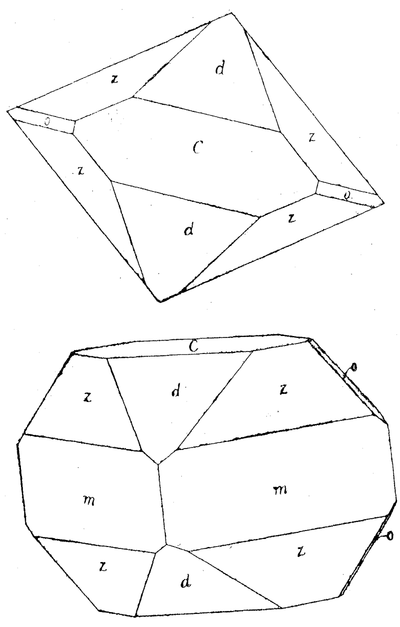

Fig. 5. Orthographic and clinographic projections of anglesite from Eveleen Mine, Northern Territory. Forms—*c*(001), *m*(110), *o*(011), *d*(102), and *z*(111).